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AIRPHOTO INTERPRETATION OF ENGINEERING SOILS OF FULTON COUNTY, INDIANA

MAY, 1967

NO. 6

by

P.T. YEH

Joint Highway Research Project

PURDUE UNIVERSITY
LAFAYETTE INDIANA

Progress Report

AIRPHOTO INTERPRETATION OF ENGINEERING SOILS
OF
FULTON COUNTY, INDIANA

To: Dr. G. A. Leonards, Director
Joint Highway Research Project

May 11, 1967

File: 1-5-2-4

From: H. L. Michael, Associate Director
Joint Highway Research Project

Project: C-36-51B

The attached report entitled "Airphoto Interpretation of Engineering Soils of Fulton County, Indiana," completes a portion of the project concerned with development of county engineering soils maps of the State of Indiana. This is the 38th report in the series. The report was prepared by P. T. Yeh, Research Engineer, Joint Research Project.

The soils mapping of Fulton County was done primarily by airphoto interpretation. Some soil test data from the previous study of this area are included in the report and generalized soil profiles of the major soil groups are presented on the soils map. An ozalid print of the Engineering Soils Map is included in the report.

Respectfully submitted,

Harold L. Michael/jgs
Harold L. Michael
Associate Director

HLM:jgs

Attachment

Copy: F. L. Ashbaucher
W. L. Dolch
W. H. Goetz
W. L. Grecco
G. K. Hallock
R. H. Harrell
V. E. Harvey
J. F. McLaughlin
F. B. Mendenhall
R. D. Miles
J. C. Oppenlander
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E. J. Yoder

Progress Report

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OF
FULTON COUNTY, INDIANA

by

P. T. Yeh
Research Engineer

Joint Highway Research Project

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Conducted by

Joint Highway Research Project
Engineering Experiment Station
Purdue University

in cooperation with the

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and the

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Federal Highway Administration
Bureau of Public Roads

The opinions, findings and conclusions expressed in this publication are those of the authors and not necessarily those of the Bureau of Public Roads.

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Purdue University
Lafayette, Indiana
May 11, 1967

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All airphotos used in connection with the preparation of this report automatically carried the following credit lines: "Photographed for Commodity Stabilization Service, Performance and Aerial Photography Division, United States Department of Agriculture."

AIRPHOTO INTERPRETATION OF ENGINEERING SOILS OF FULTON COUNTY INDIANA

by

P. T. Yeh

INTRODUCTION

The engineering soils map of Fulton County, Indiana which accompanies this report, was compiled from 7-inch x 9-inch aerial photographs having an approximate scale of 1:20,000. The aerial photographs were taken in July and August 1940 in connection with the United States Department of Agriculture program.

Aerial photographic interpretation of the land forms and engineering soils of this county was accomplished in accordance with accepted principles of observation and inference (1).* No soil samples were collected specially for this project. However, some soil samples collected in this area by Johnson in his study entitled "Airphoto Interpretation and Engineering Evaluation of Northern Indiana Sands"(2) are used in this report. Unfortunately the depth where the samples were taken was not clearly defined and in general only one sample was taken in the specific site. Grain size analysis and Atterbury limits were the only tests reported by Johnson. Wells and test boring data reported in Bulletin No. 20 entitled "Ground Water Resources of Northwestern Indiana" (3) were used to verify the interpretations in Fulton County.

Standard mapping symbols developed by the staff of the Airphoto Interpretation Laboratory, School of Civil Engineering, Purdue University, were employed to delineate land forms and soil textures. The text of this

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* Numbers in parenthesis refer to references in bibliography.

report largely represents an effort to overcome the limitation imposed by adherence to a standard symbolism.

General soil profiles of topographic highs and lows for the principle soils represented within Fulton County were included on the map. These soil profiles were prepared by reference to the "Soil Survey of Fulton County" and "The Formation, Distribution and Engineering Characteristics of Soils" (5).

DESCRIPTION OF AREA

General

Fulton County is located in the north central part of Indiana (Figure 1). The total area of the county is 367 square miles (4). Rochester is the county seat and the largest city. A population of 16,957 inhabitants resided within the county, with 4,883 reported for Rochester in the 1960 Census (6).

According to the 1959 Census of Agriculture, there were 223,161 acres of farm land (about 95% of the county area) in Fulton County (7). Wooded areas (about 18,402 acres) are generally confined to the stream and river valleys as shown on the mosaic in Figure 2.

Drainage Features

Most of Fulton County lies within the Tippecanoe subdivision of the Wabash drainage basin. Small areas (about ten square miles) in the southeast corner, however, are in the Eel subdivision of the Wabash basin.

The natural surface drainage is best developed in the area north of Tippecanoe River, where the terminal moraine is well defined. As a whole, the natural drainage is weakly developed. Numerous infiltration basins

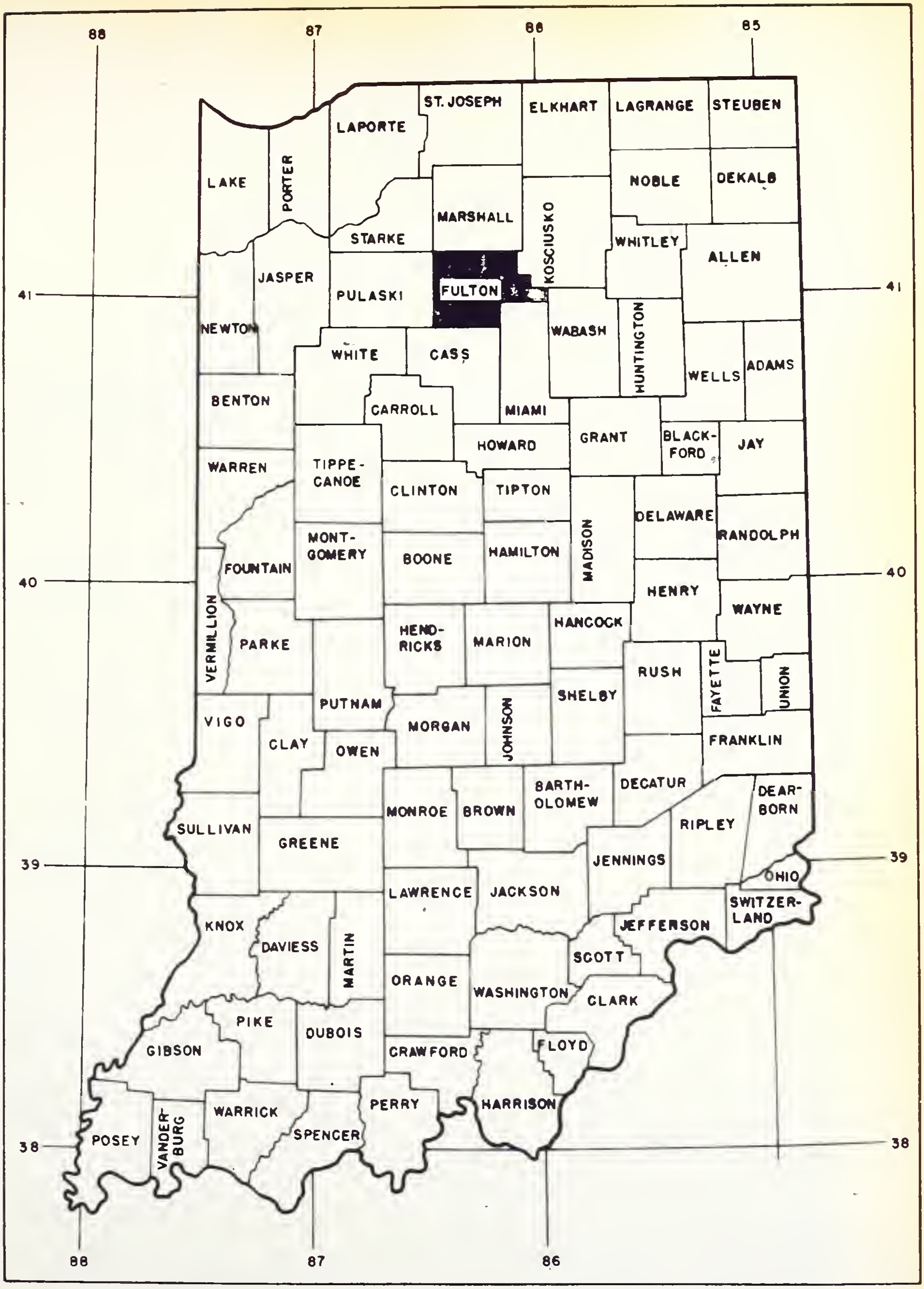


FIG. I LOCATION MAP OF FULTON COUNTY

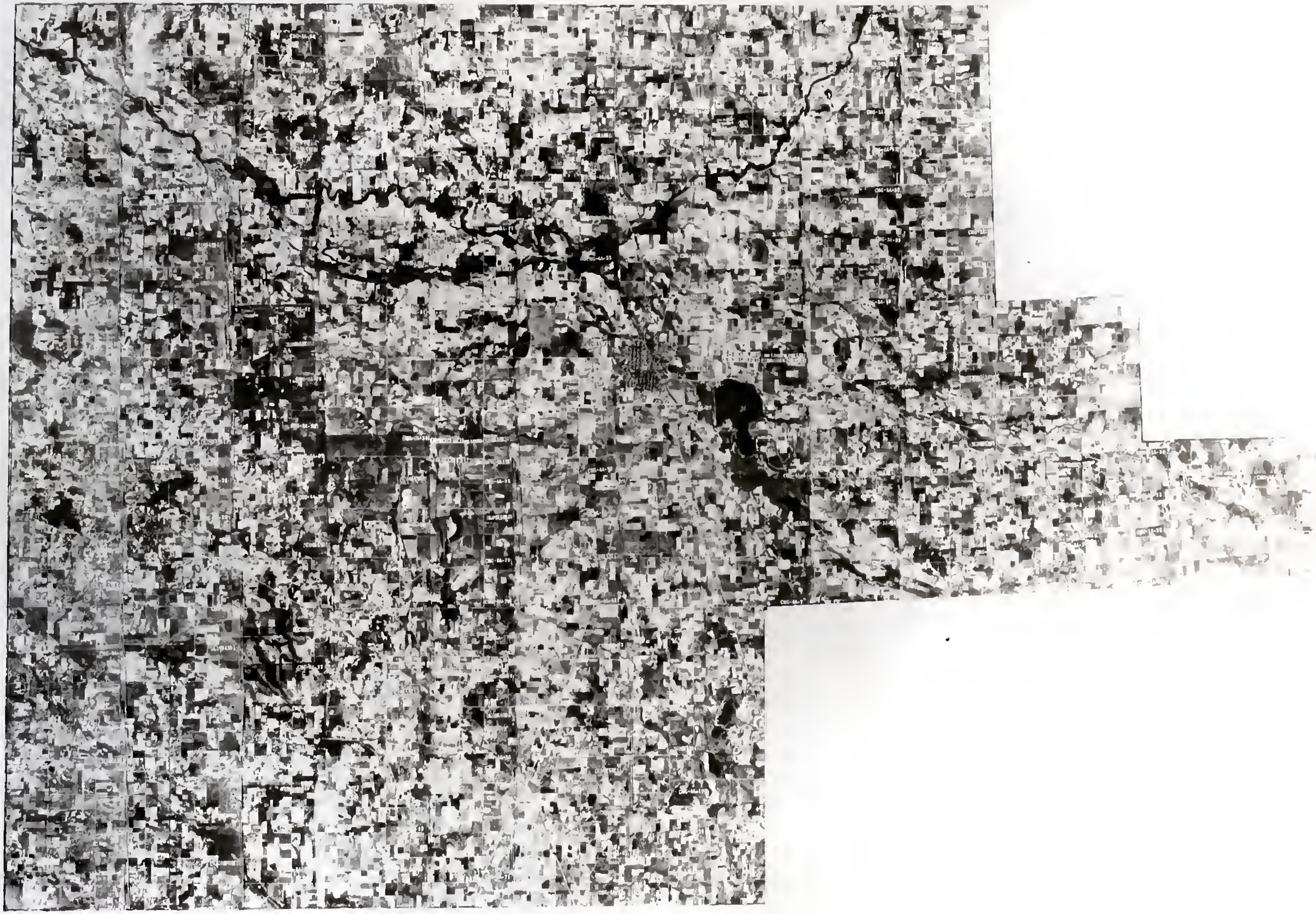


FIG. 2 AIRPHOTO MOSAIC OF FULTON COUNTY.

FROM 1940 INDEX MAP

and depressions are revealed on the drainage map (Figure 3). The drainage of the area south of Tippecanoe River is facilitated by extensive dredging and straightening at the stream channels. There are about 600 miles of open drainage ditches in the county. The straight alignment of ditches create a strong rectilinear drainage pattern.

From the low density of the drainage gullies especially in the central part of the county, the indication of flat topography and the well drained characteristics of the surface material can be deduced.

There are a number of lakes in Fulton County. Lake Manitou located about a mile southeast of Rochester is the largest. This lake is more than one square mile in area and is a summer resort for the vicinity.

Because of the glaciofluvial deposits in Fulton County, ground water (3) is plentiful especially in the central portion (See Figure 4). Shallow wells (less than 50 feet) will yield adequate quantities for domestic use in most of the county (3).

Climate

The climate of Fulton County is continental, humid and temperate. In winter cold waves from the west and northwest may drop temperature drastically. In summer hot periods may occur occasionally. However, these temperature extremes are usually of short duration. Temperature or climatic conditions do not vary greatly within the county. Rainfall is well distributed throughout the growing season. The wide variation occurring within a season can be seen from the absolute minimum and maximum temperatures listed in Table I. The average precipitation is 36,19 inches. The average amount of monthly precipitation is fairly uniform as shown in Table I (9).

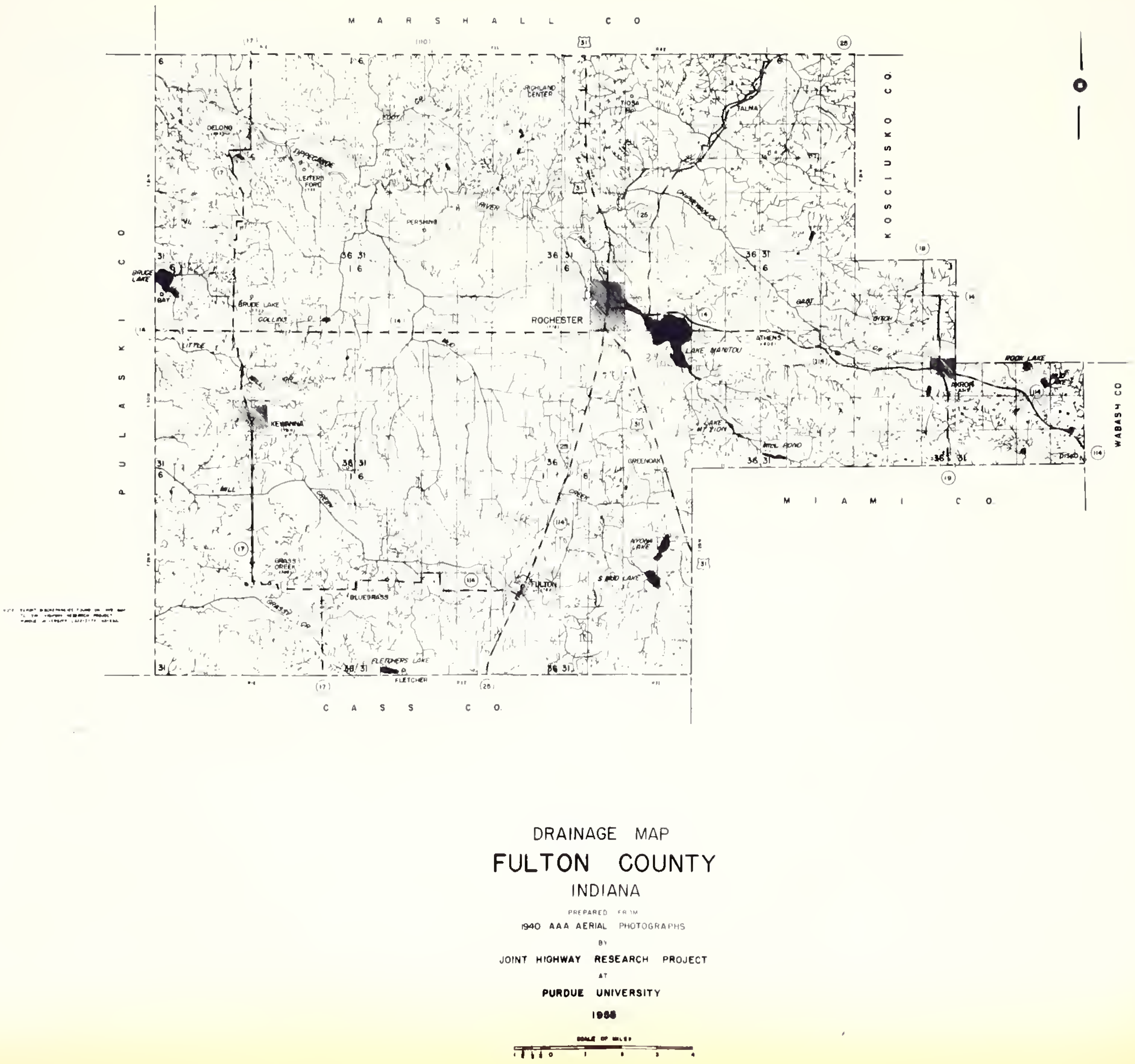
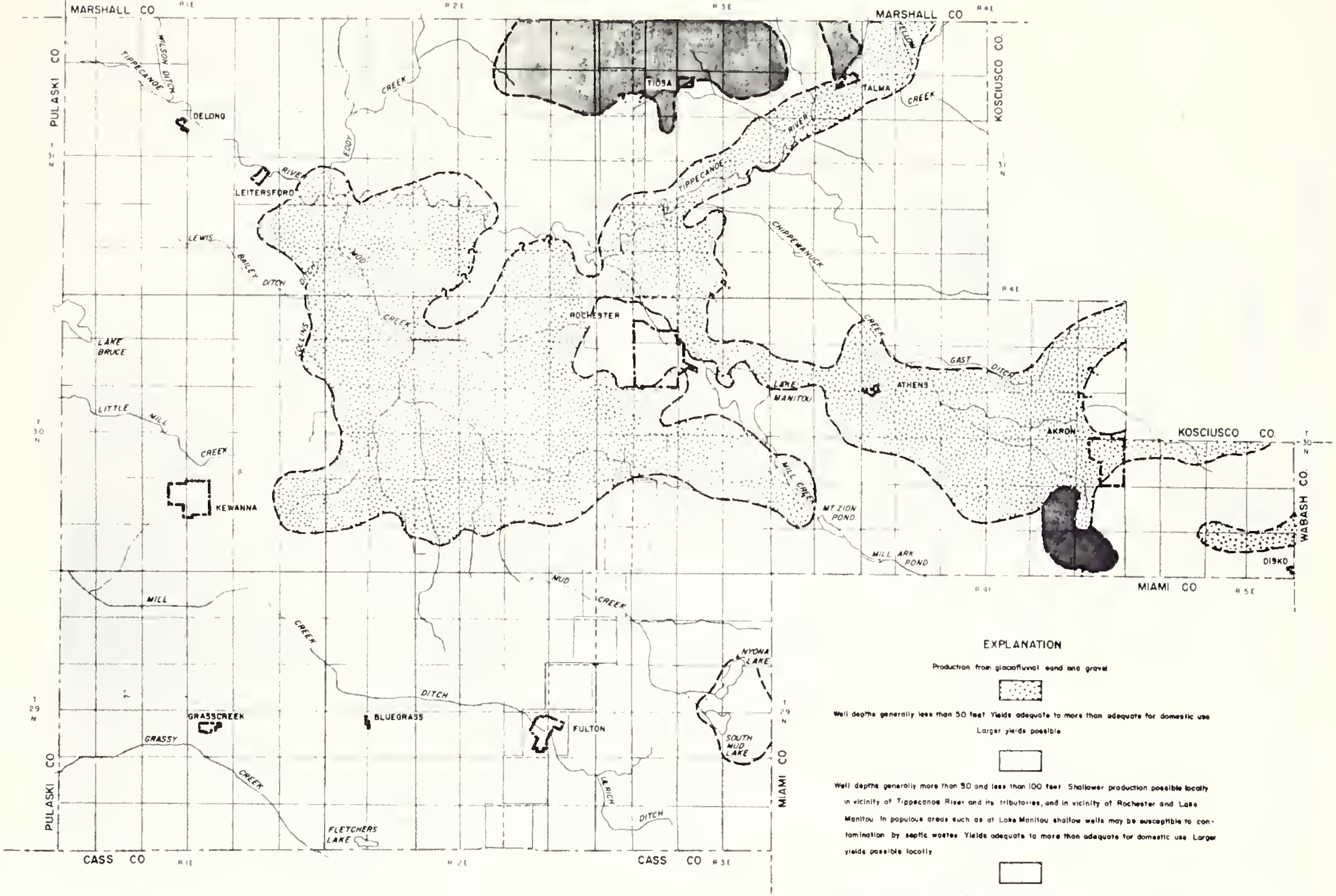

MARSHALL CO
KOSCIUSKO CO.
WABASH CO
MIAMI CO.
CASS CO.
PULASKI CO
ROCHESTER
LAKE MANITOU
ATHENS
AKRON
ROCK LAKE
DISKO
MILL POND
TALMA
TIOSA
RICHLAND CENTER
PERSHING
LEITERS FORD
DELONG
BRUCE LAKE
KEWANNA
GRASS CREEK
BLUEGRASS
FLETCHERS LAKE
FLETCHER
FULTON
NYONA LAKE
SAND LAKE
GREENOAK
DRAINAGE MAP
FULTON COUNTY
INDIANA
PREPARED FROM
1940 AAA AERIAL PHOTOGRAPHS
BY
JOINT HIGHWAY RESEARCH PROJECT
AT
PURDUE UNIVERSITY
1958
SCALE OF MILES
0
1
2
3
4

FIG. 3

STATE OF INDIANA
INDIANA DEPARTMENT OF CONSERVATION
DIVISION OF WATER RESOURCES

PREPARED BY THE
UNITED STATES DEPARTMENT OF THE INTERIOR
GEOLOGICAL SURVEY



EXPLANATION

Production from glaciofluvial sand and gravel

▨

Well depths generally less than 50 feet Yields adequate to more than adequate for domestic use Larger yields possible

☐

Well depths generally more than 50 and less than 100 feet Shallower production possible locally in vicinity of Tippecanoe River and its tributaries, and in vicinity of Rochester and Lake Manitou In populous areas such as at Lake Manitou shallow wells may be susceptible to contamination by septic wastes Yields adequate to more than adequate for domestic use Larger yields possible locally

☐

Well depths generally more than 30 feet and less than 150 feet Production from several shallow and deep sand and gravel units Yields adequate to more than adequate for domestic use Larger yields possible

■

Well depths generally more than 100 feet and less than 150 feet Yields adequate to more than adequate for domestic use Larger yields possible

— — — — — —
Boundary approximate

—?—?—?—
Boundary uncertain

6	5	4	3	2	1
7	8	9	10	11	12
18	17	16	15	14	13
19	20	21	22	23	24
30	29	28	27	26	25
31	32	33	34	35	36

DIAGRAM OF TOWNSHIP

Base from modified General Highway and Transportation Map revised to July 1953 Drainage and Town bounddries in part from U S Geological Survey topographic maps

FIG. 4

MAP OF FULTON COUNTY, INDIANA SHOWING AVAILABILITY OF GROUND WATER

0 1 2 3 4 5 6 MILES
0 5000 10000 15000 20000 FEET

By J. S Rosenshein and J D Hunn
1961

TABLE I

NORMAL MONTHLY TEMPERATURE AND PRECIPITATION AT ROCHESTER, FULTON COUNTY, INDIANA

(Elevation 779 feet)

Month	Temperature			Precipitation		
	Mean °F	Absolute Maximum °F	Absolute Minimum °F	Average Inches	Driest Year (1953) Inches	Wettest Year (1905) Inches
January	27.3	69	-20	2.00	2.83	1.84
February	28.9	70	-21	1.83	1.55	3.56
March	37.1	81	- 6	2.47	2.76	1.99
April	49.7	93	14	3.67	3.61	5.04
May	60.7	96	24	3.98	2.80	8.80
June	70.9	105	35	4.29	3.06	4.65
July	74.9	109	41	3.71	3.86	4.57
August	72.9	105	35	3.40	1.40	5.01
September	65.5	103	28	3.38	1.80	4.24
October	54.5	91	14	3.07	1.30	3.99
November	40.3	81	- 4	2.62	1.14	4.11
December	29.5	68	-30	1.77	0.84	2.44
Year	51.0	109	-30	36.19	26.50	50.24

Physiography

Fulton County lies wholly within the northern moraine and lake region. The area is subdivided into two sections. The northwest and the western portion of the county is included in the Kankakee-lacustrine section while the rest of the county lies in the Steuben morainal lake section (Figure 5).

In respect to its physiographic situation in the United States, Fulton County is a part of the Eastern Lake Section of the Central Lowland Provinces (10).

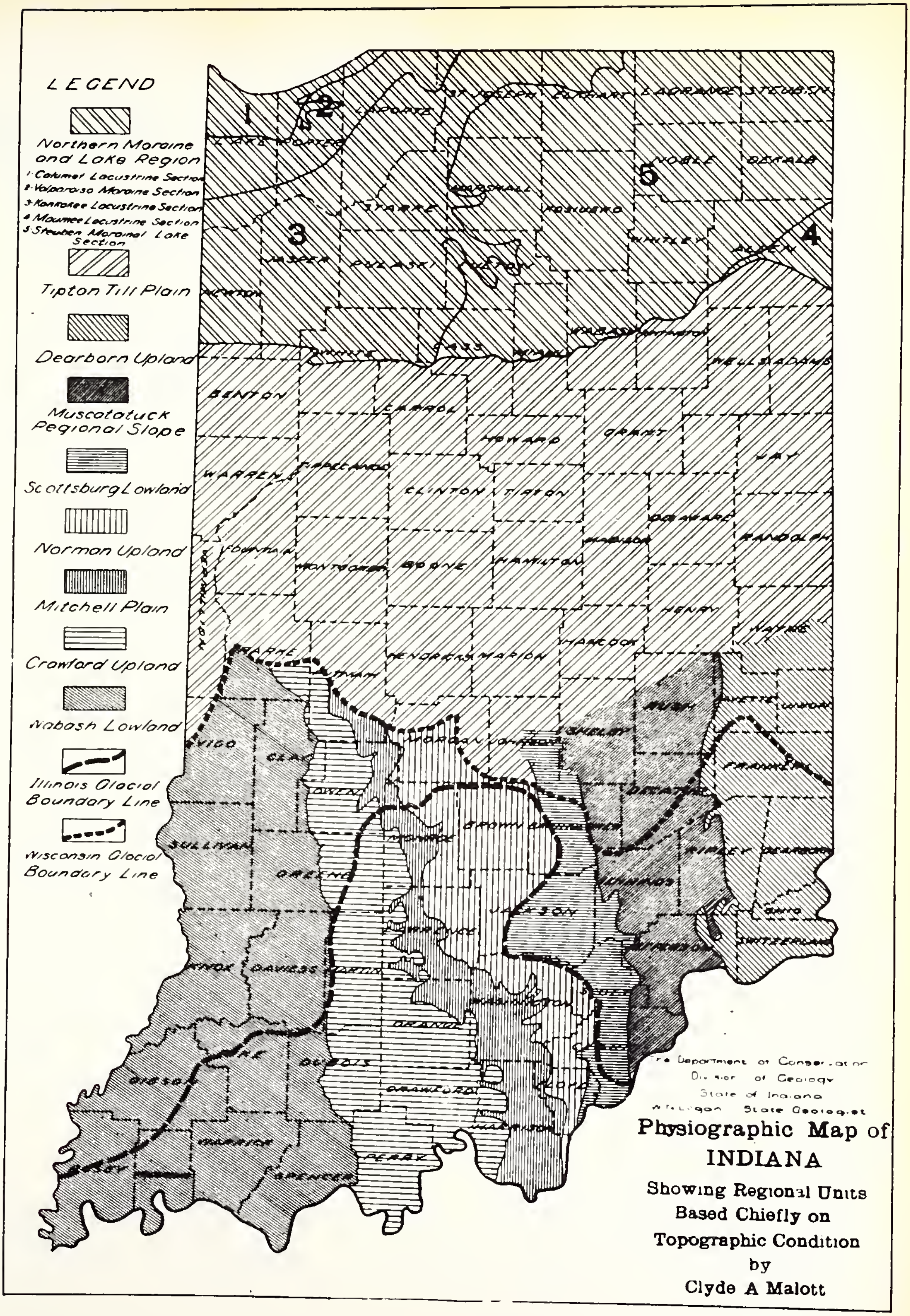
Topography

The topography of Fulton County varies from rolling morainic hills to nearly level outwash plains and slightly depressed mucky basins. The majority of the county however exhibits a very gently undulating topography. The high and more rugged areas are located north of the Tippecanoe River and the southeastern corner of Fulton County. The surface of the land slopes graduately to the northwest (see Figure 6).

The most rugged area of Fulton County lies north of the Tippecanoe River. This area which is mapped as kettle kame moraine consisting of rolling hills and basins. Much of the land is badly dissected and severely eroded.

The southeastern part of Fulton County exhibits a rolling topography. The highest elevation of Fulton County (927 feet above sea level) is located about one half mile east of Mud Lake in Section 22, T.30N., R.5E. Many lakes and ponds occur in this region.

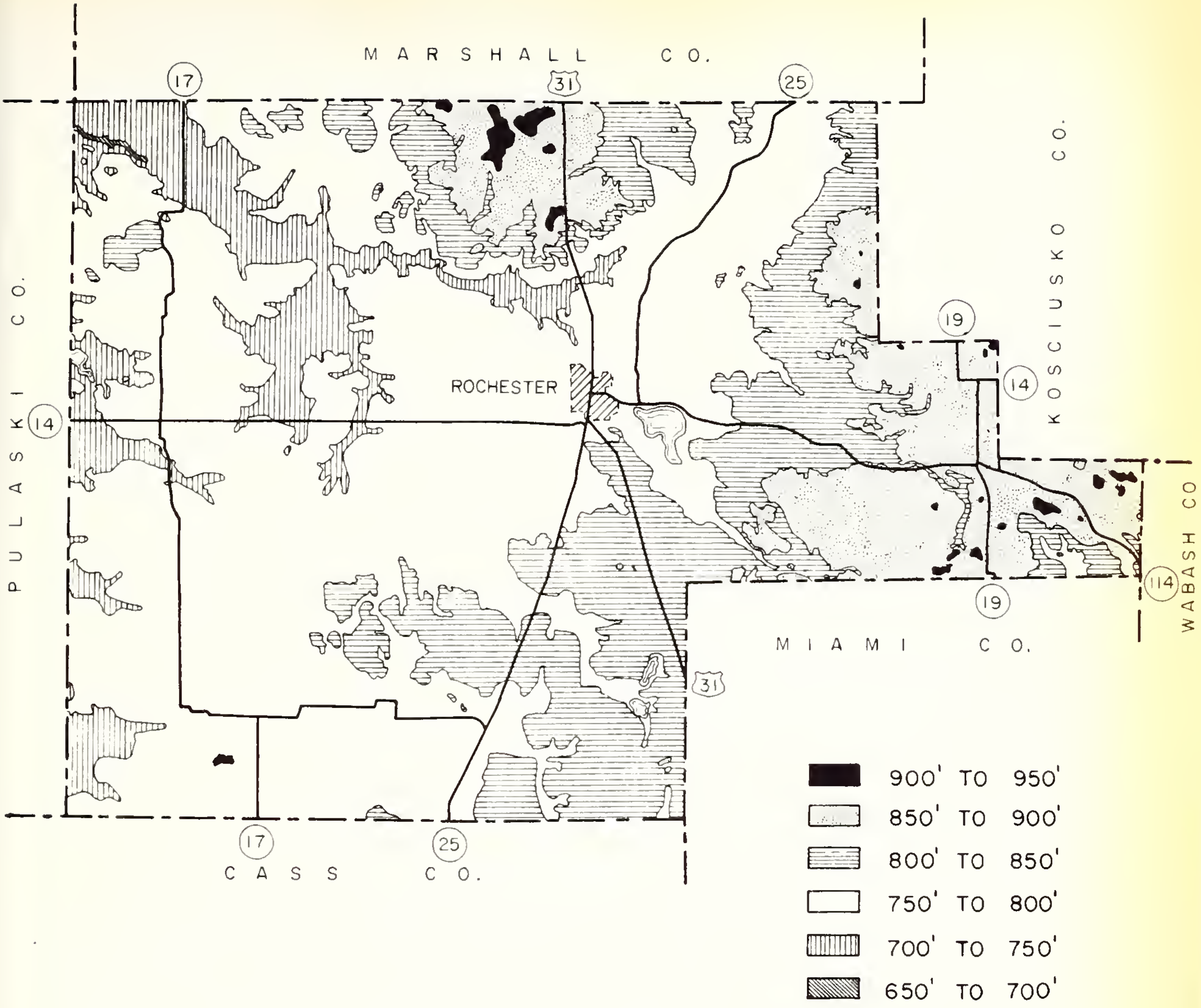
The central part of the county is occupied by a huge outwash plain. The topography of this plain is extremely flat. However, the



The Department of Conservation
Division of Geology
State of Indiana
W. N. Logan State Geologist

Physiographic Map of INDIANA
Showing Regional Units Based Chiefly on Topographic Condition
by
Clyde A Malott

FIG. 5



DERIVED FROM THE CHICAGO (NK 16-8), FORT WAYNE (NK 16-9), AND DANVILLE (NK 16-11) NATIONAL TOPOGRAPHIC 1° QUADRANGLES

SCALE 1/250,000

FIG. 6 TOPOGRAPHIC MAP OF FULTON COUNTY
(CONTOUR INTERVAL 50')

infiltration basins, mucky depressions and some wind blown sand ridges breaks the monotony of the plain.

The Maxinkuckee moraine extending between the Tippecanoe River and the southern border of the county, is very weak in topographic expression. It has a gently undulating surface and is only slightly more undulating and higher than its surrounding ground moraine. The best morainic exhibition is obtained in the portion immediately south of Tippecanoe River.

The rest of the county which is mapped as ground moraine exhibits a very gently undulating surface. In the southwestern part of the county, wind blown sand deposit may occasionally create a more rolling landscape.

A few small areas located in the northwestern corner and along the western border of the county have a sand dune topography. Some of the dunes have a typical crested form but most are irregular sand ridges. The sand-ridges are generally narrow and are usually less than 20 feet in height.

The lowest elevation (715 feet) of Fulton County is located in the northwestern corner where the Tippecanoe River leaves the county. Thus, Fulton County has a maximum relief of 212 feet. However, the greatest local relief is about 100 feet. It occurs in the kettle kame moranic belt about two miles south of Tiosa. The average altitude of Fulton County is 760 feet.

Geology

Fulton County was entirely covered by thick glacial deposits during the later phases of the Wisconsin glaciation. Well records show that the glacial drift ranges from about 100 feet to more than 250 feet in depth. The drift is classified as Lagro Formation of the Cary Age by Wayne.(11)

The deeply buried bedrocks in Fulton County are of the Mississippian Devonian and Silurian periods. The rocks of Silurian age lie below the glacial drift in a small area at the southeastern corner of Fulton County. The rocks consist of dolomite, dolomitic limestone and shale.

The rocks of Silurian age are overlain by dolomite, dolomitic limestone and sandstone of Middle Devonian age. These bedrocks occur at depth in the southern part of Fulton County.

The unconsolidated glacial deposits in the northern part of Fulton County are underlain by New Albany and Antrim shales which belong to Devonian and Mississippian age (12).

The glacial drift of the Pleistocene age varies in forms and textures throughout Fulton County. Different deposits are overlapped and overlain by the wasting of the glaciers at different times. The deposits are generally sandy in texture except on the south eastern corner where clay rich depositis prevailed. Prominent topographic features resulting from the deposition of end moraine are observed in the north and southeastern part of the county. The most outstanding morainic feature is the Maxinkuckee Moraine which is located in the north central part of the county on the north bank of the Tippecanoe River. The other part of the Maxinkuckee moraine extends south from the river toward Cass County; it is topographically weak in expression and rather narrow. On the extremely southeastern part of the county lies part of the prominent Parkerton Moraine.

A large glaciofluvial sand and gravel plain is located in the central part of Fulton County. This deposit attends a depth of 150 feet in many places. The deposit is named as Altherton Formation by Wayne (11).

The recent deposits in Fulton County consist of thin alluvium along all streams and rivers, organically rich sand, silt and clay in the depressions and thin layers of windblown sand within the western half of the county.

The geological formation of Fulton County may be summarized as follows: (12,13)

Quatenary - - - - - - - - - - - Recent, sands, clays, gravels.
Pleistocene, sands, clays, gravels.
Devonian and Mississippian - - Shale (New Albany Antrim)
Middle Devonian - - - - - - - Dolomite, dolomitic limestone and sandstone (Sellersburg, Jeffersonville)
Silurian - - - - - - - - - - - - Dolomite, dolomitic limestone and shale (Niagaran)
Ordovican - - - - - - - - - - - Limestones, shales (Richmond)
Limestone (Trenton)

LAND FORMS AND ENGINEERING SOIL AREAS

The engineering soils in Fulton County are derived from unconsolidated materials. The unconsolidated materials include glacial drift, glacial-fluvial deposits, alluvial deposits, eolian deposits and cumulose deposits.

Since the deposits of transported materials are far from homogeneous, variation should be expected. Therefore, only general properties and profile of the soil for each area of different landform are presented in this report.

Glacial Deposits

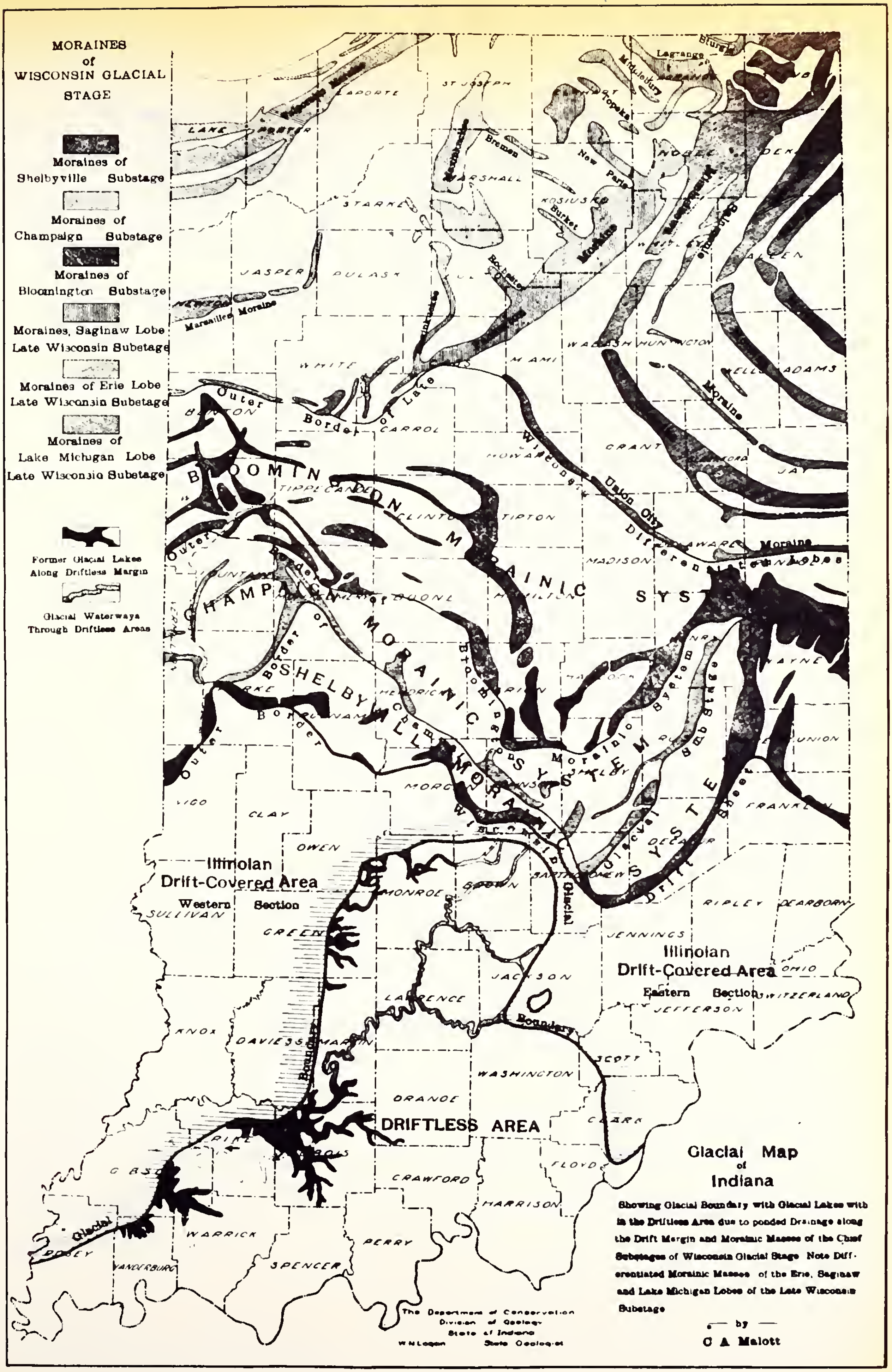
The major portion of Fulton County is covered by glacial deposits of Wisconsin Age. The landforms of this glacial deposit include ridge moraine, ground moraine, and esker and kame.

1. Ridge Moraine. Fulton County has three ridge moraines; the Maxinkuckee moraine occupies the north central and the western part of the county. The Packerton moraine lies on the southeastern corner. The Rochester moraine, a branch of the Packerton moraine, extends from Rochester to the southeastern border of the county (see Figure 7).

The texture of the ridge moraine varies greatly from one to the other and from place to place. Therefore they are subdivided into five groups namely; kettle kame ridge moraine, granular-textured ridge moraine, sandy-textured ridge moraine, medium-textured ridge moraine and clayey-textured ridge moraine.

(A) Kettle Kame Ridge Moraine. There are two ridge moranic belts mapped as kettle kame moraine in Fulton County. The larger one which is part of the Maxinkuckee Moraine lies north of the Tippecanoe River. It has an area of about nine square miles. The other about one and a half square miles in area is located southeast of Rochester on the Rochester moraine.

As the name implied the moraine has a kettle kame topography. Kettles or depressions are surrounded by kames or knobs. The general rolling or hilly relief is about 25 feet. However, relief up to 50 feet or more occurs in a number of places. The topographic expression of kettle kame moraine within the Rochester moraine is less rugged than those in the north.



The Department of Conservation
Division of Geology
State of Indiana
W N Logan State Geologist

Glacial Map
of
Indiana

Showing Glacial Boundary with Glacial Lakes within the Driftless Area due to ponded Drainage along the Drift Margin and Morainic Masses of the Chief Substages of Wisconsin Glacial Stage Note Differentiated Morainic Masses of the Erie, Saginaw and Lake Michigan Lobes of the Late Wisconsin Substage

— by —
C A Malott

FIG. 7

Because of the different depositional form in the kettle kame moraine, the soil texture varies widely. In the high position a loamy or fine sandy loam surface soil is commonly found. Due to severe erosion, the surface soil may be entirely removed on the steep slopes. The subsurface soil of a sandy texture is underlain by a gravelly sandy clay loam subsoil. A stratified gravel and sand is generally found in the parent material. However, a loamy textured soil may occur.

In the low position or depression the loam and silt loam surface soil may show a laminated structure if undisturbed. The subsurface soil varies from a silt loam to a silty clay loam and the subsoil is a more plastic silty clay. The parent material is clay loam in texture.

The variation of this deposit can be observed from the well records listed in Appendix B. Records taken in sec. 19, T.31N., R.3E. shows 18 feet of brown clay overlying four feet of gravel and 11 feet of sand and then a layer of blue clay 17 feet thick and a medium gravel stratum of 18 feet. Another well taken in section 20, T.31N., R.3E. shows a sand and gravel layer of 36 feet followed by 10 feet of sand and 12 feet of blue clay.

(B) Granular Textured Ridge Moraine. A few areas in Fulton County are mapped as granular textured ridge moraine. The largest one (about five square miles) is part of the Maxinkuckee Moraine and lies south of the Tippecanoe River in the northwestern quarter of the county near Delong. Another large area (about three square miles) is located on the Parkerton Moraine at the southeastern corner of the county, east of Fulton. A few small isolated patches are scattered along the south central portion of the county.

The topographic expression of the granular textured ridge moraine varies from a strong rolling to a pitted undulating surface. Many depressions or basins of considerable size are scattered within this morainic ridge region. The ruggedest topography lies just south of the Tippecanoe River, where local relief of 50 feet is not uncommon, between knobs and basins. Less rugged morainic expression is found in the remaining areas where maximum local relief seldom is over 25 feet.

The texture of this ridge moraine varies from one place to the other. In general, it is sandy and gravelly in texture with considerable amount of silt and clay (about 25 percent). The amount of gravel varies not only in a vertical profile but horizontally as well. The granular nature of the deposit can be deduced from the location of many gravel pits in this morainic region as shown on the soils map. The area south of the Tippecanoe River can be considered as less gravelly because of the absence of gravel pits.

The soil profile in the high position of the granular textured ridge moraine consists of a loam to sandy loam surface soil, with a sandy loam to gravelly sandy clay loam subsoil. The parent material ranges from loam till to gravel and sand mixture.

The textures of the deposits in the topographic low position is somewhat finer. The loam or sandy loam surface soil is underlain by a loam or clay loam subsoil. The C-horizon is most likely to be a loam or clay loam till.

Test site No. 1 taken at a depth of three feet consists of 4.6 percent of gravel, 79.4 percent of sand and 16.0 percent of fines (See Appendix A). It is classified as a A-2-6 soil by the AASHO Classification or a SC soil by the unified classification. Samples taken at a depth of six feet indicate a decrease of gravel and sand but the increase of fines are

mostly silt size.

Well records taken nearby in sections 8 and 9 , T.31N., R.1E., show more clay in the profile. The reader must realize that the well log description is in general a visual term recorded by a layman. Well records in section 15, T.29N., R.3E., show that there is ten feet of sand and gravel overlying 36 feet of blue clay.

(C) Sandy Textured Ridge Moraine.

The major portion of the ridge moraine in Fulton County is sandy in texture. The main body of this deposit lies in the Maxinkuckee Moraine along the western half of Fulton County. Another large segment is located in the southeastern corner of the county south of Rochester.

The topography ranges from undulating to rolling. Surface drainage is poorly developed. A pitted expression or infiltration basins are found in many areas. In general the landscape is more rugged in the portion north of the Tippecanoe River. Local relief of about 50 feet in magnitude is common along the drainage channels. The topographic difference between the ridge moraine and the ground moraine in the western part of the county south of the granular textured ridge moraine is inconspicuous. The surface roughness in many places may be attributed to windblown sand deposits. Local relief is generally about five to ten feet and seldom over 25 feet. The topography is much more subdued toward the south.

The morainic expression of the Rochester Moraine is rolling in the north and undulating toward the south. The maximum local relief occurs west of Lake Manitou.

The surface soil in this region is influenced somewhat by the windblown sand deposits from the west. The topsoil ranges from a fine sandy loam to sand with sandy loam or sand subsoil. The unweathered material

varies from a clay loam to a sandy loam. The soil profile in the low topographic area shows a finer texture. The surface soil varies from a sandy loam to an organic loam. Sandy loam, sandy clay loam or clay loam is found in the B-horizon. The parent material ranges from clay to clay loam.

Soil samples taken from sites No. 2, 3, 9, 10 and 11 illustrate that the sand content ranges from 70 to 84 percent while the fine fraction varies from 14 to 28 percent. The samples are all classified as sand clay soil except at site No. 10 as SM soil by the unified classification.

Well records taken at section 6 T.30N., R.1E. northeast of Bruce Lake show the variation of the soil. At site on SW¼, NE¼ the first 14 feet of material is sand and stony clay followed by blue stony clay. At site SE¼, NE¼ blue clay was recorded for a depth of 30 feet underlain by 29 feet of sand and gravel. Many well records in this region registered the upper layer (from 30 to 54 feet) as blue clay underlain by sand and gravel.

(D) Medium Textured Ridge Moraine

The medium textured ridge moraines are located in the southern tip and the very northeastern portion of the Maxinkuckee Moraine. Small areas on the Packerton Moraine located at the southeastern corner of the county are included in this category.

The topography is somewhat subdued. undulating to rolling landscapes prevail. The most rugged land occurs on the northern border of the county where maximum local relief reaches 50 feet. Surface drainage development is more advanced than in the sandy textured area. However, occasional infiltration basins still occur.

The soil texture of this area is somewhat less sandy and more silty than that of the sandy textured area. The surface soil is loam or sandy

loam in the high topographic positions. The subsoil ranges from a clay loam to a sandy clay loam and the parent material varies from clay loam to sandy clay loam. Organic loam to organic silty clay loam may be found on the surface in the low topographic positions. It is underlain by a silty clay to clay subsoil and a clay loam to clay parent material.

No soil samples of this area were obtained. However, soil sample No. 16 of Cass County, taken three miles south of the county border is similar (14). The B-horizon obtained two to four feet below the ground has 48 percent sand and 46 percent fines. The parent material taken from four to six feet show a decrease of sand content to 45 percent and an increase of fines. Well records taken in section 3, T.31N, R.[illegible]E. indicates the deposit is yellow and blue clay some 50 feet in depth.

(E) Clayey Textured Ridge Moraine

The clayey textured ridge moraine is confined to the Packerton Moraine located in the southeastern corner of Fulton County. It is about ten square miles in area.

The topography of this area varies from undulating to rolling. Maximum local relief seldom reaches 50 feet. Surface drainage is well developed in the more rolling area. However, a number of infiltration basins still occur in this region. High clay content occurs in the surface layers and more granular material may be found at depth. A well record in section 28, T.30N., R5E., shows 15 feet of yellow clay overlying 15 feet of gravel which in turn is underlain by 11 feet of blue clay. In section 30 T.30N., R.5E., 25 feet of gravel is overlain by a 30 foot layer of yellow clay.

The soil profile is derived from the clayey material. In the high area a loam to clay loam surface soil is underlain by a clay loam to clay

material. The subsoil varies from silty clay to clay. The parent material in this region is clay till.

2. Ground Moraine. About one third of Fulton County is occupied by ground moraine deposits. The drift deposits are predominantly loam and fine sandy loam. They are discussed in two separate groups.

(A) Sandy Textured Ground Moraine. More than one sixth of the area in Fulton County is mapped as sandy textured ground moraine. The main body lies in the southwestern quarter of the county. Small areas are scattered on the eastern half of the county adjacent to the outwash plains. The sandy surface texture of this group is likely created by a veneer of sand blown from the west.

The topography of this region is very gently undulating. The local relief generally is less than ten feet in magnitude. The poorly developed surface drainage system and the shallow infiltration basins in the area indicate the somewhat porous nature of the deposits.

The soil profile of sandy textured ground moraine is similar to that of the ridge moraine except that the A-horizon is thicker and a little more loamy in texture. In the low topographic area the textures of the upper layer are more silty and clayey than that of the ridge moraine. The surface soil varies from a loam to an organic silt loam. The subsoil ranges from clay loam to silty clay. The parent material is clay loam or clay.

Soils sampled at site Nos. 12, 13, 14 and 15 by Johnson (2) reveal the sandy textured surface soil. The sand content ranges from 74 percent to 92 percent. A soil sample taken in Cass County at site No. 18 (14) also is representative. The sample obtained between one to three feet from the surface contains 72 percent sand and 28 percent fines. The

C-horizon taken from four to six feet is composed of 60 percent sand and 32 percent fine.

Well records also indicate the effect of wind blown sand. For example, in Section 20 T.30N., S.3E., there are five feet of yellow clay on 13 feet of hard blue sandy clay. In section 28, 27 feet of sand is found overlying seven feet of clay but in section 30 only four feet of sand is found on top of 17 feet of yellowish clay.

(B) Medium Textured Ground Moraine. Less than one sixth of Fulton County is mapped as medium textured ground moraine. The main body lies on the northeastern quarter of the county. Others occur near the south border of the county.

The landscape in this region is a very gently undulating plain. The influence of windblown sand in this region is minor.

The soil textures of the medium textured ridge moraine and ground moraine are essentially the same. However, because of the less erosional effect on the subdued topography in the ground moraine, the A-horizon is thicker than that of the ridge moraine. The parent material contains more clay than in the area of ridge moraine.

Soils sampled at site No. 26 by Johnson (2) indicates 72 percent of sand and 25 percent of fines at a depth of two feet from the surface. Cass County soil samples taken by Becker and Yeh (14) at site No. 10 (about two miles south of Fulton County) reveals the following: The B-horizon sampled between a depth of 1.5 to 2.5 feet is composed of 40 percent of sand and 55 percent of fines. The parent material taken at a depth from 2.5 to 3.5 feet below the surface has 44 percent sand and 49 percent of fines.

Soil sample No. 6 taken in Kosciusko County located just east of the eastern border and about 2.7 miles south from the north border of Fulton County shows a somewhat coarse texture (15). The coarseness of the deposit may be attributed to the proximity of the outwash plain. The B-horizon obtained at a depth of one to two feet below the ground surface contains 19 percent gravel, 38 percent sand and 43 percent fines. The C-horizon taken three to four feet below the surface shows a slight decrease of gravel (14 percent) an increase of sand (44 percent). Another site (No. 5) in Kosciosko County taken about one half mile from section 1 T.30N., R.4E., is more clayey than the previous site. The B-horizon (1 to 2 feet from surface) has 6 percent gravel, 27 percent sand and 67 percent fines. The C-horizon taken four feet below the surface is composed of 9 percent gravel, 33 percent of sand and 58 percent fines.

Well records show that many interbedded gravel and clay layers occurred in this region. Gravel layers are found at a depth of 10 to 40 feet from the ground surface. For example, records taken in section 23, T.28N., R.2E., show three feet of gravel underlain by 17 feet of brownish clay which overlies four feet of blue clay, a four foot layer of gravel and a thick strata of blue clay. Wells drilled in section 2, T.30N., R.4E., shows 13 feet of gravel is sandwiched between 28 feet of yellowish clay and 17 feet of blue clay.

3. *Eskers and Kames*. Many kame deposits occur in Fulton County. They occur mainly in the kettle kame ridge morainic belt and have been discussed. Only a few small ones are scattered in the ground moraine region near Kewanna and Fulton. There is only one esker in Fulton County. It is located southeast of Rochester and west of Lake Manitou. It is about one mile in length and is named as "Big Hill." The maximum local relief is

about one hundred feet above the adjacent outwash plain to the east.

The granular texture of this deposit is confirmed by the presence of gravel pits. The soil profile is essentially the same as that of the kettle kame ridge moraine. Therefore, no separate profile is developed for this land form.

Fluvial Deposits

About one quarter of the area of Fulton County is covered by fluvial deposits. These water-deposited materials occur in the form of outwash plains, sluiceways, terraces and alluvial plains.

1. Outwash Plains. The majority of the fluvial deposit is in the form of an outwash plain or sluiceway. The main body lies along the Tippecanoe River and Chippewanuck Creek in the central part of the county. The outwash plain deposits are divided into five textural groups namely: gravelly outwash plain, sandy outwash plain, gravelly with fine outwash plain, highly organic sandy outwash plain and highly organic gravelly outwash plain.

(A) Gravelly Outwash Plain. The gravelly outwash plains occur mainly in the eastern half of Fulton County. Only a few small areas located between Leiters Ford and Pershing and an area about two miles east of Kewanna are mapped as gravelly outwash plains in the western half of the county.

These gravelly outwash plains all have a typical outwash plain air-photo pattern. Infiltration basins are numerous and many current scars occur. The surface of the outwash plain varies from gently rolling to nearly level. Steep slopes occur around the infiltration basins.

The surface soil of this region may have been influenced by some windblown sand deposits. It is a fine sandy loam in texture. The sub-surface soil varies from loam to sand and the subsoil is a gravelly clay loam.

Stratified gravel and sand is found at a depth from two to four feet from the surface. In the low area the surface soil varies from loam to fine sandy loam in texture. The subsoil is a sandy gravelly clay loam. The stratified gravel and sand occur below a depth from 2.5 to 8 feet.

The well records in this region verified the gravelly nature of this deposit. In section 16, T.31N., R.3E., the site on NE¼, NE¼, show 25 feet of dirty sand and gravel on 15 feet of clean sand and gravel. At another site in this section there is 33 feet of coarse gravel overlying 15 feet of bluish clay. In section 36, T.31N., R.1E., the top 25 feet is recorded as hard brownish gravel on 9 feet of soft grayish clay which in turn is underlain by 8 feet of gravel and 8 feet of sand. In the eastern part of the area wells drilled at the NW¼, NE¼ in section 12, T.31N., R.3E., shows that the top 18 foot layer is a red gravelly sand with clay on 18 feet of white sand.

(B) Sandy Outwash Plain. The sandy outwash plains occur exclusively on the western half of Fulton County. The main body is located along the Tippecanoe River in the northwestern quarter of the county. A few small deposits lie between Kewanna and Fulton and some along Grassy Creek.

The topography varies from undulating to level. The surface is more irregular to the northwest corner where wind blown sand deposits affect the sandy outwash plain along the Tippecanoe River. A number of large sand dunes are delineated on the map. The infiltration basins are not as extensive as on the gravelly outwash plain. Current scars occur only sparingly. From the airphoto the surface appears much smoother than that of the gravelly outwash plain.

The soil profile of the sandy outwash plain consists of a loamy fine sand surface soil with fine sand and sand subsurface soil. The subsoil in the high position usually consists of a fairly cohesive fine sand seams alternating with layers of loose sand. The unweathered layer is composed of loose sand and fine sand.

Soil samples taken at site No. 7 at a depth from 3.5 - 4.0 feet by Johnson shows that the sample contains 2.6 percent gravel, 94.8 percent sand and 2.6 percent fines. It is identified as a poorly graded sand. At site No. 8 soil taken from the surface down consists of 1.4 percent gravel, 93 percent sand and 5.6 percent fines. This nonplastic material is also identified as poorly graded sand.

(C) Gravelly with Fines Outwash Plain. Five small areas are mapped as gravelly with fines outwash plains. The largest one (about one square mile in area) lies about three miles northwest of Fulton. The others are located about one and one-half miles east of Kewanna, about one mile south of Grass Creek and less than one half mile west of Delong.

This region lies slightly lower than the surrounding morainic areas. The topography is characterized by a gently rolling to undulating surface. Surface drainage is almost absent. However, slight depressions serve as infiltration basins.

The soil in this group as the name implied contains some fines. In the high positions, a fine sandy loam surface soil is underlain by a heavy sandy loam. The subsoil is a sandy and gravelly clay loam. The parent material is gravel and sand mixed with some silty and clayey material.

In the low topographic areas the surface soil is an organic loam. The subsoil is loam and changes into silt loam and then to a gravelly clay loam.

(D) Highly Organic Topsoil Gravelly Outwash Plain. This deposit is associated closely with the gravelly outwash plains. They occur mainly in the eastern half of the county. However, the deposits are concentrated within a few miles northeast and southwest of Rochester.

The topography of these areas is extremely level. The airphoto shows a more uniform gray tone which is darker than the slightly higher gravelly outwash plain but lighter than the muck deposit. The infiltration marks and current scars are entirely absent. Due to the low topographic position this deposit occupies, the water table is relatively high and a surface drainage system has not developed.

On the slightly higher areas the surface soil varies from an organic silt loam to an organic sandy loam. The organic material decreases rapidly with depth and the subsoil is the same texture as the surface but without organic material. In the B-horizon where clayey materials are accumulated; the texture ranges from silty clay loam to sandy clay loam. The parent material found two to three and one half feet from the surface is a calcareous gravel and coarse sand. In the low topographic areas the soil profile is essentially the same as mentioned above except that the surface and subsurface soils are thicker and a gravelly clay loam or sand and fine gravel may be found in the subsoil.

(E) Highly Organic Topsoil Sandy Outwash Plain. These deposits lie exclusively on the western half of Fulton County. They are associated with the sandy outwash plains. The main body lies along Mud Creek between Rochester and Kewanna. It is almost a continuous plain broken only by muck channels and basins.

The topography of this deposit is extremely flat. Only very minute changes of elevation occur between the high and low areas. The land is

only about five feet higher than the muck channels or basins. The airphoto pattern of the area resembles a till plain pattern overshadowed by a more or less uniform gray tone (see Figure 8). The gray tone of this deposit is a result of high organic content on the topsoil and a high water table.

Soil profiles of this deposit on the slightly high ground consists of an organic sandy loam to an organic loamy sand top soil, a loamy sand to sand subsoil and fine sand to sand parent material. In the topographic low positions, the surface soil is high in organic matter. In the undisturbed areas the upper two to three miles is a black colored loamy muck. High organic loam or sandy loam follows to a depth from 16 to 27 inches. The organic content of the topsoil is much higher than that in the high positions. Fine sand is found in the subsoil and calcareous loose fine sand occurs in the C-horizon.

2. Terraces. A river or stream terrace is defined as a bench like deposit derived by fluvial action within the river valley. Since the material is sorted by water, stratification of the material is evident.

In Fulton County there are few terrace deposits. The only area which can be classified as a terrace lie on the north bank of the Tippecanoe River about one and one half miles north west of Pershing. A definite break between the upland can be observed on the airphotos. Since the area is very small and the texture is similar to the surrounding gravelly outwash plain, no separation is attempted for the soil map.

3. Alluvial Plains. Alluvial plains in Fulton County are confined to the Tippecanoe River. The alluvial plain is rather narrow with a maximum width of about one half mile. The continuity of the alluvial deposit is

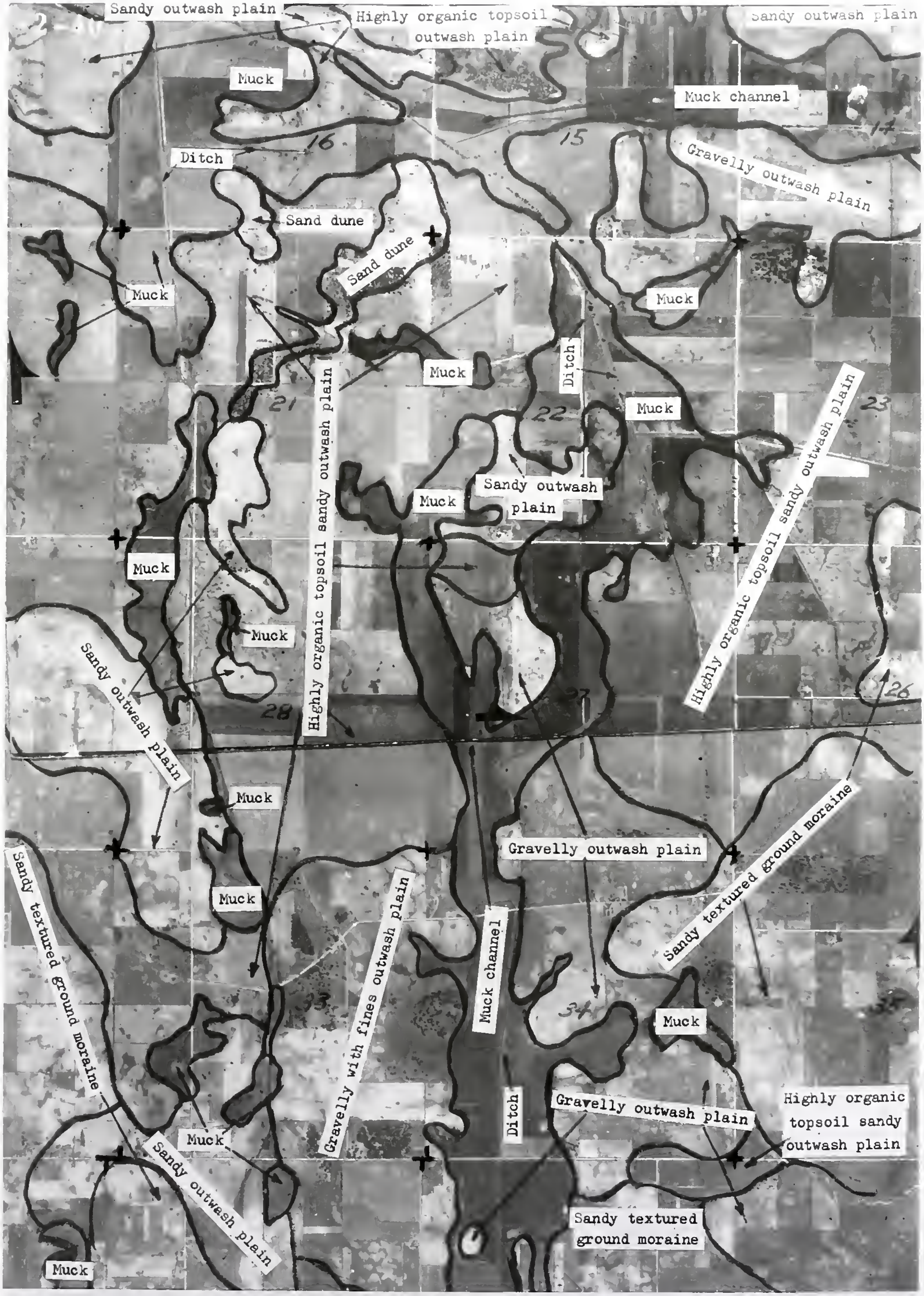


FIG. 8. AIRPHOTO PATTERNS OF HIGHLY ORGANIC TOPSOIL SANDY OUTWASH PLAIN AND GRAVELLY WITH FINES OUTWASH PLAIN.

broken by muck channels and outwash plains at the eastern portion of the river.

Most of the alluvial plains have flat to nearly level surfaces. Natural levees may be developed in some areas. Abandoned channels or channel scars occur in a number of places. The dark airphoto tonality in these areas is indicative of the high water table. The alluvial plains in Fulton County are mainly forested.

The texture of the alluvial deposits varies greatly both horizontally and vertically from one place to the other. Coarse textured sandy deposits are located near the natural levees. The surface soil varies from loam, sandy loam to loamy sand. The underlying layers are also extremely variable. Sandy loam, loamy fine sand and sand with gravel are the possible textures. Sand, silt and fine gravel are usually found at depth.

In the low topographic areas high organic material accumulates on the surface. The subsoil ranges from loam to fine sand, stratified sand, silt and gravel are found at depth.

Eolian Deposited Material

Eolian deposited material in Fulton County is limited to windblown sand deposits. On the northwestern portion of the county the surface is covered by a thin blanket of windblown sand as mentioned previously. Only the thick deposits are considered as eolian deposited material, and are mapped as sand dunes.

A large concentration of sand dune deposits are located in the northwestern corner of the county. Many isolated ones or groups are scattered on the till plains and outwash plains in the western half of the county. The shapes of sand dunes are irregular in Fulton County. However, a few isolated dunes, particularly those on the outwash plains have a crescent-like

shape. The widths of the dunes are narrow and their height is generally less than 20 feet above the surrounding land. However, in the larger sand dune regions gently rolling to dune like topography prevails and the maximum local relief may reach 50 feet or more. Surface drainage is not well developed. In the steep slope areas, however, short gullies may develop. Blowouts are the unique form of erosional feature in this deposit.

The upper portion of soil profile consists of a loamy fine sand surface soil followed by a loamy sand or sand subsoil. The lower portion of the soil profile depends on the original surface upon which the sand dune is superimposed. If it is on the glacial drift region, a sandy clay loam textured till is found beneath the windblown sand at a depth four feet or more from the surface. If the sand dune is developed on outwash plains then a stratified sand and gravel outwash deposit occurs at depth.

In the low topographic area in the sand dune region the surface soil is composed of a deep layer (from 18 to 42 inches) of loamy sand to sandy loam. The subsoil ranges from a sandy clay loam to sandy loam. The loamy texture till is found from two to six feet below the surface.

Soil samples taken at sites 4, 5 and 6 by Johnson show that the surface soils contain about 97 percent sand and less than 3 percent fines. They are identified as a non-plastic sand.

Well records taken in sections 8, T,31N., R.1E., reveal about 18 feet of sand with streaks of yellow clay in the top layer. It is underlain by 10 feet of sand and 20 feet of dirty sand and gravel before the 22 foot clay substratum is reached.

Cumulose Materials

Accumulation of cumulose or organic materials occur on the various land forms previously described. The most frequently occurring cumulose deposits are found in the kettle basins on the ridge and ground moraines. However, many drainage channels on the outwash plain in Fulton County are filled with the cumulose deposits. On relatively flat areas or slight depressions, highly organic topsoils may occur. Since those on the outwash plains have been discussed, only those small isolated areas are considered in the following discussion.

1. Kettle Basins and Channels. Cumulose deposits of muck and peat occur in numerous kettle basins and glacial-fluvial drainage channels throughout Fulton County. The larger deposits occur along the glacial-fluvial channels which extend several miles in length and in places about one half mile in width. All the basins and channels have a uniform dark tone on the airphotos. The surface is extremely flat. Drainage ditches are commonly employed to lower the high ground water table in these areas.

Most of the peats are derived from mosses, sedges and wood. In some kettle basins a soft layer of marl is found under about 12 to 42 inches of muck. Marl is an earthly material composed principally of an amorphous form of calcium carbonate. Since it is also undesirable from the engineering standpoint, no separation is made from the peat and muck in the soil profile illustrated.

The soil profile consists of a loamy muck surface soil. However, in some areas, particularly in the ridge morainic region, where the erosion of material from the surrounding area is severe, the surface soil is a loam underlain by a silt loam before the underlying coarse granular to fibrous

peat is reached. Sand is frequently found beneath the muck and peat deposits.

The depth of these cumulose deposits varies greatly from one location to another. This can be illustrated from well records (3). For example, in section 25 T.30N., R.4E., there is six feet of muck underlying 14 feet of marl. At another site in NW¼, NE¼ of section 21 T.31N., R.1E., 10 feet of muck overlies 30 feet of blue clay. Field investigation of each individual deposit is required.

2. Highly Organic Topsoil Depressions. Depression areas, where external and internal drainage is somewhat retarded, particularly on the morainic areas, give rise to the accumulation of organic topsoil. A few small deposits occur in Fulton County. Most of them lie in the northern half of the county. The only one in the southern half of the county lies about one mile east of Bluegrass. The others are located one mile north east of Athens, a short distance north of Tosa, about one mile west of Richland Center, and in the sand dune and moraine areas at the northwestern corner of the county.

The soil profile is essentially the same as that of the surrounding deposit except for the surface layer. The surface soil ranges from an organic loam to an organic sandy loam. The subsoil varies from silty clay loam to sand and the C-horizon is composed of clay loam or sand depending on the origin of deposit.

3. Swamps. There are two areas mapped as swamp in Fulton County. The swamp located south of Lake Manitou was formed by the damming of the outlets of the lake. It is surrounded by muck and peat basins on three sides and is connected with Lake Manitou to the north. The other swamp is located just east of S. Mud Lake.

The swamp is essentially a muck and peat deposit submerged by water. The depth of water is generally less than a few feet and the level is kept more or less stationary. The underlying material below the muck and peat deposits is frequently sandy in texture. Since the depth of this organic deposit varies from one location to the other, field exploration is essential.

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tic t	Plastic Index %	Classification	
		Unified	AASHO
9	10.9	SC	A-2-6
2	5.7	SM-SC	A-2-4
1	13.4	SC	A-2-6
1	8.2	SC	A-2-4
	NP	SP	A-3
	NP	SP	A-3
	NP	SP	A-3
	NP	SP	A-1-b
	NP	SW-SM	A-3
3	7.7	SC	A-2-4
0	0.5	SM	A-2-4
9	12.8	SC	A-2-6
	NP	SM	A-2-4
	NP	SW-SM	A-2-4
3	5.6	SM-SC	A-2-4
9	10.5	SC	A-2-6
	NP	SW-SM	A-3
5	5.3	SM-SC	A-2-4

entitled
thwest

APPENDIX A

SOIL TEST DATA FOR FULTON COUNTY

Site No.	Sample No.	Depth in Inches	Grain Size Distribution % Passing						Liquid Limit %	Plastic Limit %	Plastic Index %	Classification	
			No. 4	No. 10	No. 20	No. 40	No. 100	No. 200				Unified	AASHO
1.	2181	36	95.4	85.6	63.2	48.2	24.7	16.0	24.8	13.9	10.9	SC	A-2-6
	2182	72	99.3	91.3	73.7	61.6	38.9	28.2	19.0	13.2	5.7	SM-SC	A-2-4
2.	2186	0-12	99.1	90.5	68.0	51.8	30.2	21.0	30.4	17.1	13.4	SC	A-2-6
3.	2180	4	98.6	93.6	73.3	57.5	37.3	28.0	25.3	17.1	8.2	SC	A-2-4
4.	2179	0-12	100.0	99.8	99.7	96.3	17.7	2.2	NP	NP	NP	SP	A-3
5.	2185	0-12	100.0	100.0	99.7	94.5	17.5	2.2	NP	NP	NP	SP	A-3
6.	2175	0-12	99.8	99.8	99.3	92.0	14.8	2.5	NP	NP	NP	SP	A-3
7.	2184	42-48	97.4	81.7	60.5	38.1	5.6	2.6	NP	NP	NP	SP	A-1-b
8.	2183	0-12	98.6	94.6	87.3	74.6	11.5	5.6	NP	NP	NP	SW-SM	A-3
9.	2174	24	99.1	87.3	67.1	52.0	19.4	14.9	26.0	18.3	7.7	SC	A-2-4
10.	2172	2-18	98.8	96.6	87.1	76.6	39.5	27.8	14.4	14.0	0.5	SM	A-2-4
11.	2193	48	100.0	94.1	78.8	66.4	40.9	26.9	26.7	13.9	12.8	SC	A-2-6
12.	2176	0-18	98.9	97.4	91.6	82.0	37.4	20.0	NP	NP	NP	SM	A-2-4
	2177	0-12	99.7	98.3	95.9	86.2	27.1	11.4	NP	NP	NP	SW-SM	A-2-4
13.	2178	4	97.6	89.8	73.8	59.3	35.0	24.0	16.9	11.3	5.6	SM-SC	A-2-4
14.	2189	4	97.7	91.8	74.3	60.6	29.6	17.5	26.5	15.9	10.5	SC	A-2-6
15.	2390	0-24	100.0	100.0	100.0	89.6	18.5	7.5	NP	NP	NP	SW-SM	A-3
16.	2217	24	97.1	89.0	71.3	59.5	37.0	24.9	16.8	11.5	5.3	SM-SC	A-2-4

The soil test data tabulated above was taken from a thesis entitled "Airphoto Interpretation and Engineering Evaluation of Northwest Indiana Sands" by A. Morgan Johnson.

APPENDIX B

SELECTED LOGS OF WELLS AND TEST HOLES IN FULTON COUNTY, INDIANA

The selective record tabulated below was taken from Bulletin No. 20 entitled "Ground-Water Resources of Northwestern Indiana, Preliminary Report: Fulton County," by The Geological Survey United State Department of the Interior in cooperation with the Division of Water Resources, Indiana Department of Conservation, 1964.

A. Kettle Kame Ridge Moraine Region

At SW$\frac{1}{4}$, NE$\frac{1}{4}$ of Section 17 T.31N. R.3E. Altitude: 840 feet

Driller's Log from Memory.

Material	Thickness (in feet)	Depth (in feet)
Clay, brown - - - - -	18	18
Gravel - - - - - - -	4	22
Sand - - - - - - - -	11	33
Clay, blue - - - - -	17	50
Gravel, medium - - -	18	68
Blue clay at 65 feet		

At NE$\frac{1}{4}$, SE$\frac{1}{4}$ Section 20, T.30N., R.3E. Altitude: 800 feet

Material	Thickness (in feet)	Depth (in feet)
Sand and gravel - - - - -	36	36
Sand - - - - - - - - - - -	10	46
Clay, blue - - - - - - - -	12	58
Gravel, fine to very coarse - -	2	60

B. Granular Textured Ridge Moraine Region

At SE¼, SE¼, Section 8, T.31N. R.1E. Altitude: 751 feet

Material	Thickness (in ft.)	Depth (in ft.)
Soil; black organic silty clay with trace of sand	4	4
Clay, silty, brown and gray with trace of sand and gravel	5	9
Clay, silty, gray, with trace of sand and gravel	7	16
Gravel, sand, gray with trace of silt and clay	1	17
Clay, silty, gray with trace of sand and gravel	15	32

At SW¼, SW¼, Section 9, T.31N., R.11E. Altitude: 776 feet

Material	Thickness	Depth
Brown organic silty clay with trace of sand	3	3
Clay, silty, sandy, brown with trace of gravel	9	12
Clay, silty gray with trace of sand and gravel	8	20
Sand, gray with trace of silt	12	32

At SW¼, NW¼, Section 15, T.31N., R.11E. Altitude: 810 feet

Material	Thickness	Depth
Sand and small stone	10	10
Clay blue	36	46
Sand, fine with some gravel	1	47
Clay, blue	73	120
Silt	30	150

C. Sandy Textured Ridge Moraine Region

At SW¼, NE¼, Section 6, T.30N., R.1E. Altitude: 727 feet

Material	Thickness (in ft.)	Depth (in ft.)
Sand and stony clay	14	14
Clay, stony, blue	7	21
Clay and gravel, blue	1	22
Clay, stony; blue and brown soft clay .	14	36
Clay stony, blue with sand	3	39
Clay, soft, blue and sand mixed	17	56
Sand	2	58
Gravel, [illegible] size and larger	4	62

At SE¼, NE¼, Section 6, T.29N., R.1E. Altitude: 724 feet

Material	Thickness (in ft.)	Depth (in ft.)
Clay, blue	30	30
Sand and gravel	30	60
Gravel	[illegible]	62

D. Medium Textured Ridge Moraine Region

At NE¼, SW¼, Section [illegible], T.[illegible]N., R.[illegible]E. Altitude: 815 feet

Driller's Log from Memory

Material	Thickness (in ft.)	Depth (in ft.)
Clay, yellow and blue	50	50
Record missing	10	60
Sand	30	90
Clay blue	21	111
Gravel	4	115

E. Clayey Textured Ridge Moraine Region

At SW$\frac{1}{4}$, SW$\frac{1}{4}$, Section 28, T.30N., R.5E. Altitude 872 feet

Material	Thickness (in ft.)	Depth (in ft.)
Clay, yellow - - - - - - - - - - - - - -	15	15
Gravel - - - - - - - - - - - - - - - -	15	[illegible]
Clay, blue - - - - - - - - - - - - - -	11	[illegible]
Gravel - - - - - - - - - - - - - - - -	5	[illegible]

At SW$\frac{1}{4}$, SW$\frac{1}{4}$, Section 30, T.30N., R.5E. Altitude 876 feet

Material	Thickness (in ft.)	Depth (in ft.)
Clay, yellow - - - - - - - - - - - - -	10	[illegible]
Gravel - - - - - - - - - - - - - - - -	[illegible]	[illegible]
Clay, blue - - - - - - - - - - - - - -	[illegible]	[illegible]
Gravel - - - - - - - - - - - - - - - -	5	[illegible]

F. Sandy Textured [illegible] Moraine Region

At SW$\frac{1}{4}$, NW$\frac{1}{4}$, Section [illegible], T.[illegible], R.[illegible] Altitude [illegible]

Material	Thickness (in ft.)	Depth (in ft.)
Top Soil and Yellow Clay - - - - - - -	[illegible]	5
Clay, hard, sandy, blue - - - - - - - -	[illegible]	[illegible]
Gravel, hard, coarse, [illegible] to gray -	16	[illegible]

At SE$\frac{1}{4}$, NW$\frac{1}{4}$, Section [illegible], T.30N., R.[illegible] Altitude [illegible]

Material	Thickness (in ft.)	Depth (in ft.)
Sand - - - - - - - - - - - - - - - - -	12	12
Sand, fine gray - - - - - - - - - - - -	15	27
Clay and stone; hard - - - - - - - - - -	7	34
Silt, fine and grey quick sand - - - -	[illegible]	61
Sand, coarse - - - - - - - - - - - - - -	[illegible]	[illegible]
Gravel, coarse, [illegible] - - - - - - -	5	75

G. Medium Textured Ground Moraine Region.

At SW$\frac{1}{4}$, NE$\frac{1}{4}$, Section 23, T.29N. R.2E. Altitude: 790 feet

Material	Thickness (in ft.)	Depth (in ft.)
Top Soil - - - - - - - - - - - - - - - - - -	1	1
Clay, brown - - - - - - - - - - - - - - - - -	16	17
Gravel coarse, blue - - - - - - - - - - - - -	3	20
Clay, blue - - - - - - - - - - - - - - - - -	4	24
Gravel, medium, blue - - - - - - - - - - - -	4	28
Clay, blue - - - - - - - - - - - - - - - - -	8	36
Clay, blue and sand mixed - - - - - - - - -	14	50
Gravel medium blue - - - - - - - - - - - - -	14	64
Clay gray - - - - - - - - - - - - - - - - -	24	88
Gravel medium blue - - - - - - - - - - - - -	7	95

At SW$\frac{1}{4}$, SW$\frac{1}{4}$, Section 2, T.30N., R.4E. Altitude: 855 feet

Material	Thickness (in ft.)	Depth (in ft.)
Clay, yellow - - - - - - - - - - - - - - - -	29	29
Gravel - - - - - - - - - - - - - - - - - - -	13	42
Clay, blue - - - - - - - - - - - - - - - - -	17	59
Gravel - - - - - - - - - - - - - - - - - - -	5	64

H. Gravelly Outwash Plain

At NE$\frac{1}{4}$, NE$\frac{1}{4}$, Section 16, T.30N., R.3E. Altitude: 778 feet

Material	Thickness (in ft.)	Depth (in ft.)
Sand and gravel dirty - - - - - - - - - -	25	25
Sand, medium and gravel, clean - - - -	13	38
Sand, medium - - - - - - - - - - - - - -	2	40
Sand, fine, dark gray - - - - - - - - -	9	49
Sand fine to medium - - - - - - - - - -	6	55
Sand medium - - - - - - - - - - - - - -	3	58
Sand medium with few gravel - - - - - -	2	60
Sand coarse - - - - - - - - - - - - - -	6	66

At SE$\frac{1}{4}$, NE$\frac{1}{4}$, Section 16, T.30N. R.3E.   Altitude: 787 feet

Driller's Log from Memory

Material	Thickness (in ft.)	Depth (in ft.)
Gravel, coarse - - - - - - - - - - - - - -	33	33
Clay, blue - - - - - - - - - - - - - - -	15	48
Gravel - - - - - - - - - - - - - - - - -	4	52

At SE$\frac{1}{4}$, SW$\frac{1}{4}$, Section 36, T.31N. R.1E.   Altitude: 755 feet

Material	Thickness (in ft.)	Depth (in ft.)
Gravel, hard, brown - - - - - - - - - - -	25	25
Clay, soft, gray - - - - - - - - - - - -	9	34
Gravel, coarse, blue - - - - - - - - - -	8	42
Sand, fine, yellow - - - - - - - - - - -	8	50
Sand, coarse white - - - - - - - - - - -	5	55

I. Sand dune Region

At SE$\frac{1}{4}$, NE$\frac{1}{4}$, Section 8, T.31N. R.3E.   Altitude: 720 feet

Material	Thickness (in ft.)	Depth (in ft.)
Sand with streak of yellow clay - - - -	18	18
Sand - - - - - - - - - - - - - - - - - -	10	28
Sand, gray and gravel, dirty - - - - -	20	48
Clay, blue - - - - - - - - - - - - - - -	22	70
Sand with some gravel - - - - - - - - -	4	74
Gravel, pea-sized - - - - - - - - - - -	4	78

J. Kettle Basins and Channels Region

At NW$\frac{1}{4}$, SW$\frac{1}{4}$, Section 25, T.30N. R.4E. Altitude: 830 feet

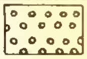
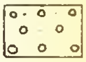
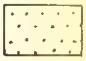
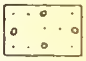
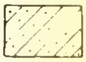
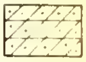
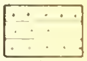
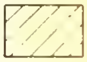
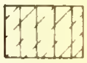
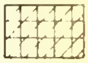
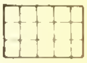
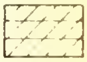
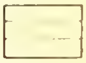
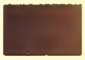
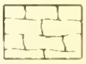
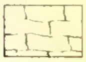
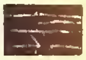
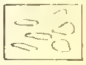
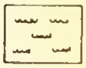
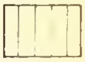
Material	Thickness (in ft.)	Depth (in ft.)
Muck - - - - - - - - - - - - - - - - -	6	6
Marl - - - - - - - - - - - - - - - - -	14	20
Gravel, marl and sand, mixed - - - - -	3	23

At NW$\frac{1}{4}$, NE$\frac{1}{4}$, Section 21, T.31N. R.1E. Altitude: 743 feet

Material	Thickness (in ft.)	Depth (in ft.)
Muck - - - - - - - - - - - - - - - - -	10	10
Clay, blue - - - - - - - - - - - - - -	30	40
Clay, blue and gravel, mixed - - - - -	80	120
Quick sand - - - - - - - - - - - - - -	10	130
Gravel - - - - - - - - - - - - - - - -	11	141

APPENDEX C

SOIL CLASSIFICATION AND PROFILE SYMBOLS

Description	Grain Size Distribution				Plastic Index	Symbol
	Gravel % Retained on #10	Sand #10–#200	Silt 0.05–0.005mm	Clay Less than 0.005mm		
Gravel	85–100	0–15	0–10	0–10	NP	
Sandy Gravel	50–85	15–50	0–10	0–10	6 Max.	
Sand	0–15	85–100	0–10	0–10	NP	
Gravelly Sand	20–49	45–85	0–10	0–10	6 Max.	
Sandy Loam	0–19	50–80	0–50	0–20	6 Max.	
Sandy Clay Loam	0–19	50–80	0–30	20–30	10 Max.	
Sandy Clay	0–19	55–70	0–15	30–45	11 Min.	
Loam	0–19	30–50	30–50	0–20	10 Max.	
Silt Loam	0–19	0–50	50–100	0–20	10 Max.	
Silty Clay Loam	0–19	0–30	70–100	20–30	11 Min.	
Silty Clay	0–19	0–15	55–70	30–45	11 Min.	
Clay Loam	0–19	20–50	50–80	20–30	11 Min.	
Clay	0–19	0–55	0–55	30–100	11 Min.	
Peat or Muck						
Limestone						
Sandstone						
Shale						
Stony Fragments						
Organic Matter						
Topsoil						

Classification of Gravelly Soils

85%–100% gravel plus finer material – Gravel
50%–84% gravel plus finer material – Clayey, silty or sandy gravel
20%–49% gravel plus finer material – Use fine classification and called gravelly sand, gravelly silt or gravelly clay
0%–19% gravel plus finer material – Use fine classification only

[illegible]

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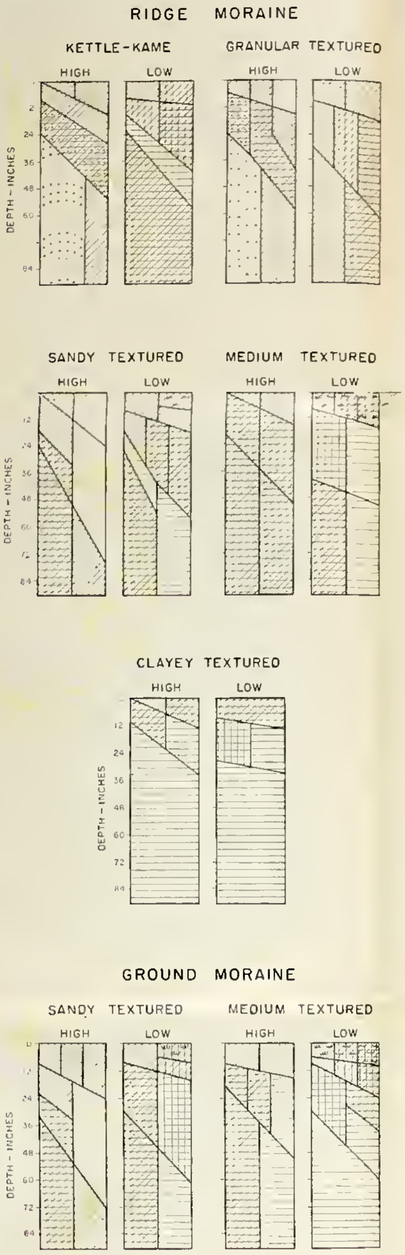
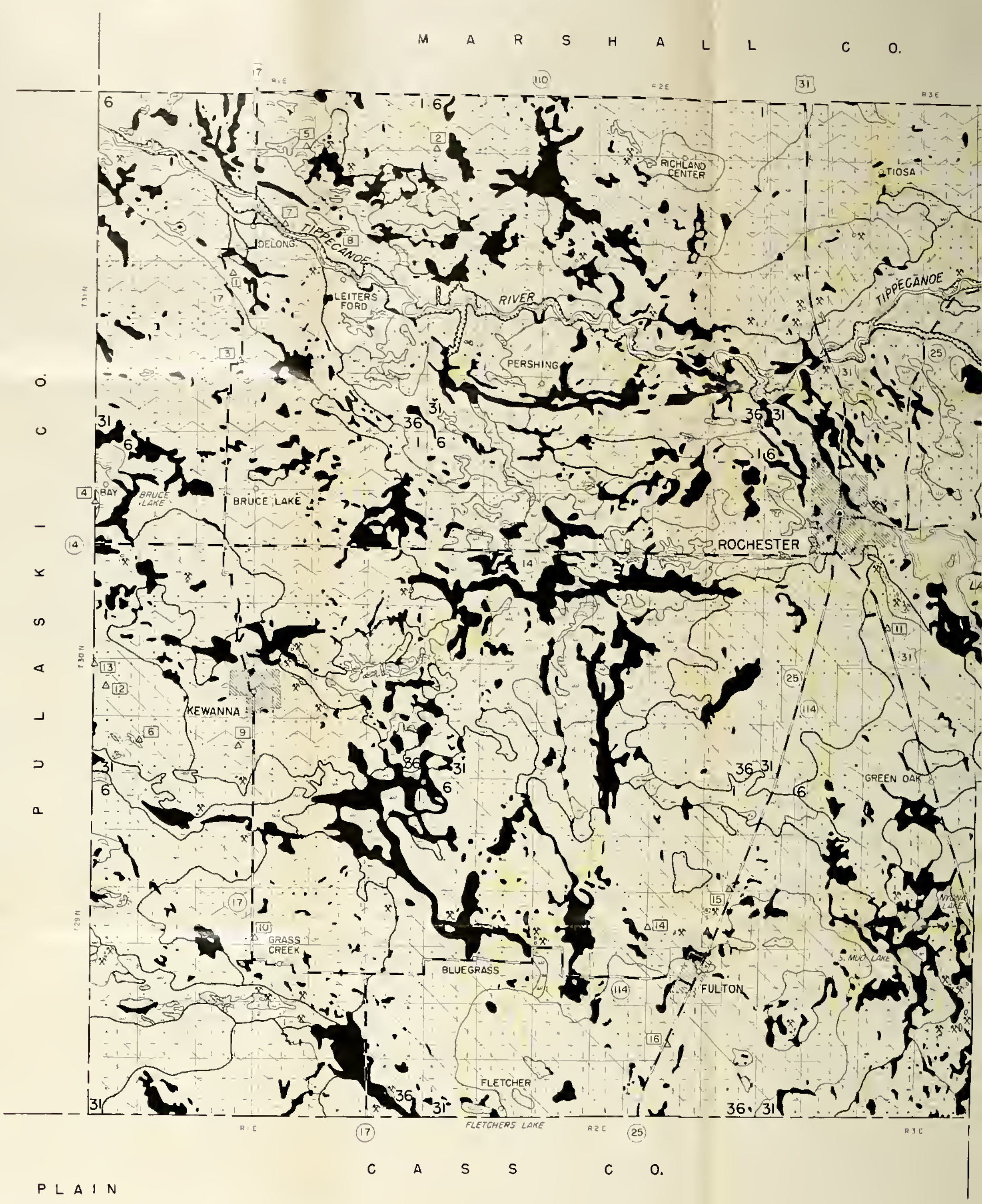
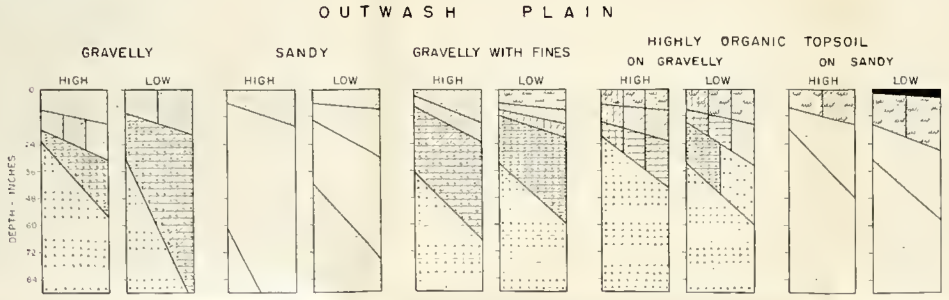
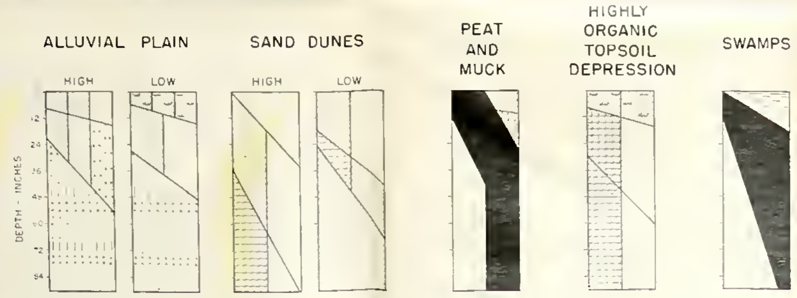
GENERAL SOIL PROFILES









ENGINEERING SOILS MA

FULTON COUNTY

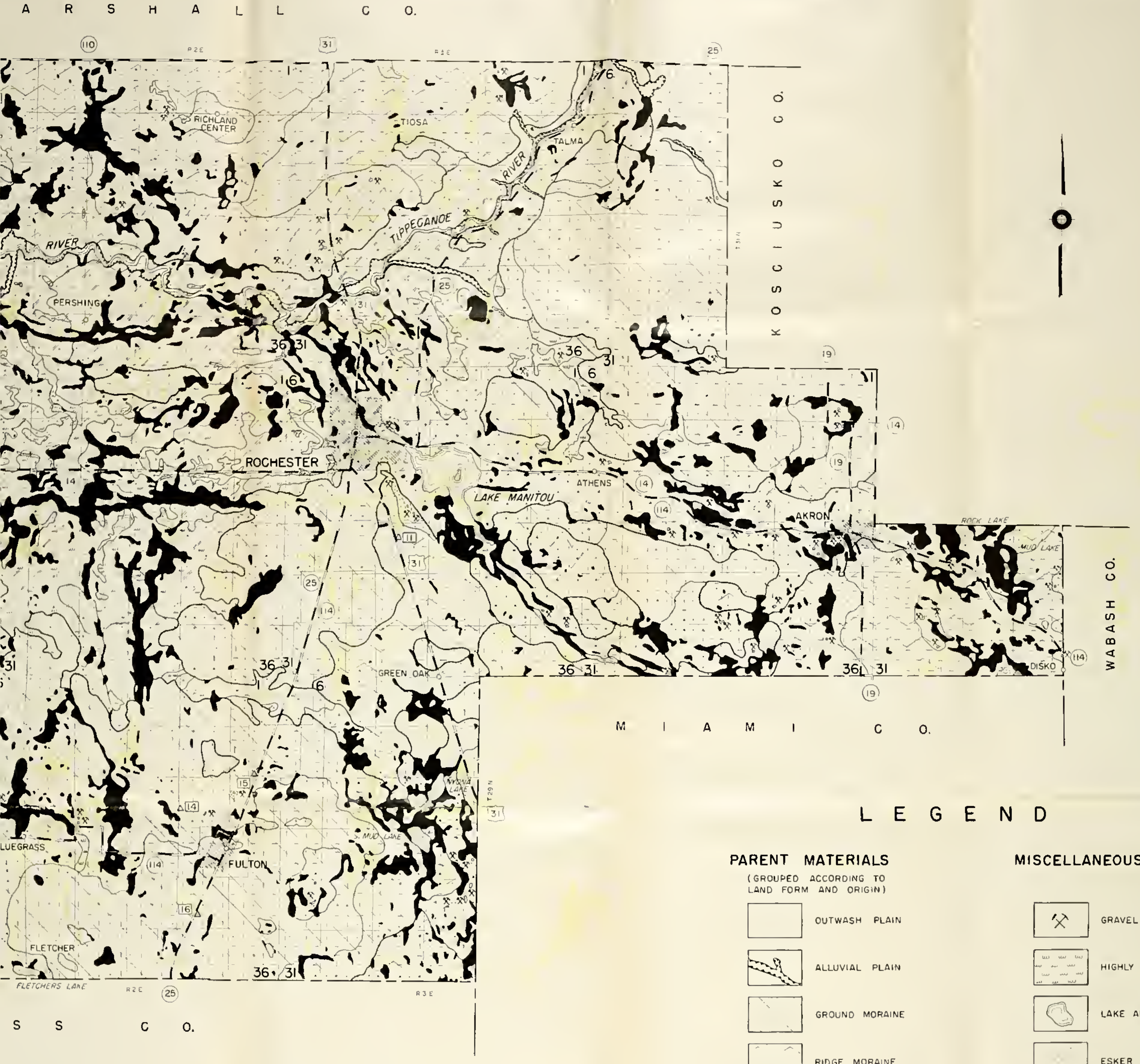
INDIANA

PREPARED FROM
1940 AAA AERIAL PHOTOGRAPHS
BY
JOINT HIGHWAY RESEARCH PROJECT, PURDUE UNI
SPONSORED BY
INDIANA STATE HIGHWAY COMMISSION
SOIL CONSERVATION SERVICE
AND
BUREAU OF PUBLIC ROADS
1967

SCALE OF MILES
1 3/4 1/2 1/4 0 1 2 3 4

POLYCONIC PROJECTION

PREPARED UNDER THE SUPERVISION OF P T YEH



L E G E N D

PARENT MATERIALS

(GROUPED ACCORDING TO LAND FORM AND ORIGIN)

- OUTWASH PLAIN
- ALLUVIAL PLAIN
- GROUND MORAINE
- RIDGE MORAINE
- KETTLE-KAME MORAINE
- SAND DUNE
- PEAT AND MUCK

MISCELLANEOUS

- ⚒ GRAVEL PIT
- HIGHLY ORGANIC TOPSOIL
- LAKE AND POND
- ESKER
- MARSH
- △ SOIL SAMPLING SITE
- KAME

TEXTURAL SYMBOLS

(SUPERIMPOSED ON PARENT MATERIAL SYMBOLS TO SHOW RELATIVE COMPOSITION)

- GRAVEL
- SAND
- SILT
- CLAY

TEXTURAL SYMBOLS FOR SOIL PROFILES

- GRAVEL
- SAND
- SILT
- CLAY
- LOAM
- ■ PEAT AND MUCK
- ORGANIC MATTER
- WATER

ENGINEERING SOILS MAP

FULTON COUNTY

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SCALE OF MILES
3/4 1/2 1/4 0 1 2 3 4

POLYCONIC PROJECTION

DRAWN BY Y. K. TANG